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FERROMAGNETIC INK TRACKS AND TOYS AND PROCESSES FOR MAKING THE SAME

BACKGROUND OF THE INVENTION

This invention relates to toy vehicles and tracks. More particularly, the invention relates to toy vehicles that can travel along a magnetic track on a play board using self-guiding mechanisms.

Play boards for various types of traveling toys that use magnetism to guide the toy along a metallic path on a game board are well known. Typically, a traveling toy, such as a toy train, follows a guide path which is made from a substrate of non-ferromagnetic material having embedded therein a ferromagnetic material in the form of wire or tape. The wire or tape is either affixed to the surface of the plate or is embedded in a groove carved in the surface of the plate. Often, a fanciful image depicting roadways and landscape is placed over the top of the plate and ferromagnetic material.

In typical operation, the toy vehicle has a pivoting magnet and guide wheel assembly at the forward end of the vehicle. A separate drive wheel propels the traveling toy forward or backwards. As the magnet at the forward end of the vehicle is attracted to the ferromagnetic guide path, the magnet and guide wheel assembly pivots in the direction of the path change causing the vehicle to turn into the direction of the path change.

Typically, the play boards are complicated and costly to produce. In addition, the traveling toys often include a large number of components which add to the cost of the toy. Therefore, there is a need for a new process for making play boards with a ferromagnetic guide path in a more efficient, less costly manufacturing process. Also, there is a need for more efficiently manufacturing the traveling toys, and making them with fewer parts.

SUMMARY OF THE INVENTION

The present invention, in one embodiment, provides a process for making a ferromagnetic guide path play board that includes the steps of providing a

supporting substrate, providing a ferromagnetic ink that includes iron powder, printing the ink onto the substrate, and applying a graphic image over the substrate.

The present invention, in a second embodiment, provides a magnetically guided traveling toy that includes a toy body, motor driven wheels at the rear of the body, and a magnetically guided wheel assembly at the forward end of the body. The magnetically guided wheel assembly includes a pivotable housing, a forward projecting arm, a magnet disposed at the end of the forward projecting arm, and one wheel having axis of rotation located perpendicular to and intersecting with the pivot axis of the housing. Preferably, the housing is connected to the toy body such that the housing pivots to center automatically when the toy vehicle is lifted off of the playing board.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded perspective view of a magnetically guided toy vehicle.

FIG. 2 is an exploded perspective view of a second embodiment of a magnetically guided toy vehicle showing in detail the magnetically guided wheel housing and assembly.

FIG. 3 is an exploded perspective view of a third embodiment of a magnetically guided toy vehicle.

FIG. 4 is a perspective view of a play board with ferromagnetic tracks and a robot figurine traveling along the track.

FIG. 5 is a perspective view of a play board having ferromagnetic railroad tracks.

FIG. 6 is a perspective view of a play board for a toy automobile.

FIG. 7 is a perspective view of another embodiment of a play board for a toy automobile.

FIG. 8 is a perspective view of yet another embodiment of a play board in the form of a storybook with ferromagnetic tracks for a toy vehicle.

FIG. 9 is an exploded perspective cutaway view of various play boards with ferromagnetic tracks made according to various processes.

FIG. 10 is a perspective view of a play board with hidden ferromagnetic tracks, and a toy animal that is activated by movement across those ferromagnetic tracks.

FIG. 11 is a plan view of another embodiment of a play board.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 depicts one embodiment of a magnetically guided toy vehicle. The toy vehicle 10 includes a vehicle body 11 in which a motor gear box 12 is located. Preferably the motor gear box 12 is spring actuated. A windup knob 13 extends out of the gear box 12 and beyond the side of the vehicle body 11. The knob 13 provides the mechanical input means to windup the spring motor inside the motor gear box. The motor gear box 12 also includes a drive axle 14 that extends out both sides of the vehicle body. On the ends of the drive axle, wheels 15 are attached to drive the vehicle. A vehicle cap 16 is placed over the top of the gear box on top of the body to enclose the motor gear box. The motor gear box and drive wheels are located at the rear end of the vehicle.

At the forward end of the vehicle, there is a magnetically guided front wheel assembly 17. The wheel assembly 17 includes a front wheel holder 18 that is pivotally mounted into a vehicle body front wheel cylinder 19. The holder is held in the cylinder by a fastener 20 such as a large head screw, inserted in the top end of the wheel holder 18 through the cylinder. At the bottom end of the wheel holder 18 and inline with the pivot axis, a single front wheel 21 is located. The wheel rotates about a shaft 22, or axle, that is perpendicular to that holder pivot axis. The shaft 22 also extends beyond the wheel, through a yoke in the holder, and through apertures 23 in a magnet holder 24. The magnet holder 24 has an opening that fits around the outside of the front wheel holder 18 at the wheel axle. The axle 22 maintains the magnet holder 24 in a fixed position relative to the front wheel holder 18. This enables the magnet holder 24 to rotate with the front wheel

holder 18. The magnet holder 24 includes a projecting arm 25 extending forward, at the forward end of which a magnet 26 is placed on the lower side.

FIG. 1A depicts the components of the toy vehicle 10 assembled together in a cross-section view. From the cross-sectional view, it is apparent that the magnet 26 is suspended by the projecting arm 25 at about the same level as the bottom of the plane formed by the bottom of the wheels of the toy vehicle. The magnet 26 is located in close proximity to the play board on which the toy vehicle is intended to drive.

FIG. 2 depicts an exploded perspective view of a second embodiment of a toy vehicle 30. In this embodiment, a vehicle chassis 31 is provided that includes a mounting bracket 32 at the rearward end for mounting a motor gear box 33, such as a spring windup gear box. The spring windup gear box 33 includes a knob 34 for winding the spring, as well as a drive axle 35 with two wheels 36 extending on either side of the gear box at the ends of the axle. At the forward end of the chassis 31, there is a housing 37 for a magnet/wheel holder 38. A vehicle body 39 is provided that attaches to the top of the chassis 31 and covers the motor gear box 33. In this embodiment, the vehicle body 39 takes the form of an autobus.

As seen more clearly in the detailed exploded view, FIG. 2A, the housing 37 forms a hollow cylindrical sleeve 40 into which a cylindrical body of a magnet/ wheel holder 38 is inserted. The magnet/wheel holder 38 is maintained in the housing sleeve 40 with a fastener 41, such as a large head screw, but the magnet/wheel holder 38 is able to rotate and slide up and down in the housing sleeve 40. The housing sleeve 40 has a V-shaped notch 42 on either side of the forward direction of travel of the vehicle for supporting a centering shaft 43. The centering shaft 43 passes through the upper end of the magnet/wheel holder 38 and extends to both sides of the sleeve 40 to rest in the V-notch 42. At the low point of the V-notch, with the centering shaft 43 supported at that point, the magnet wheel holder 38 is positioned to maintain the direction of travel of the vehicle in the forward center direction of the vehicle. At the bottom end of the magnet/wheel holder 38, there is a front wheel axle 44 that holds the wheel 45 in position at the bottom of the holder 38. The wheel axle 44 is perpendicular to the

direction of travel of the wheel, and also intersects the pivot axis of the magnet/ wheel holder 38. The magnet/wheel holder 38 also has a forward projecting arm 46 extending from its base, at the distal end of which, a magnet 47 is located on the bottom side of the arm 46. The bottom surface of the magnet 47 is positioned at a height approximately the same as the bottom of the forward wheel 45 such that the magnet glides in close proximity to, or on, the surface of the play board on which the vehicle is traveling.

The steering mechanism for the toy vehicle has a self-centering feature. The centering shaft 43 is positioned high enough in the magnet/wheel holder 38 so that when the vehicle 30 is sitting or traveling along a play board, the centering shaft 43 is pushed above the bottom of the V-notched support 42, as shown in FIG. 2C. When the toy vehicle 30 is lifted off of the play board, the magnet/wheel holder 38 slides down and the housing sleeve 40, the centering shaft 43 hits the V-notch shape 42. Gravity will cause the centering shaft 43 to follow the edge of the V-notch 42 down to the bottom point of the V-notch, as shown in FIG. 2B. As mentioned previously, the bottom point of the V-notch 42 is set perpendicular to the direction of travel so that with the perpendicular centering shaft 43 located there, the wheel 45 will center automatically to the forward direction for travel of the vehicle when the vehicle is lifted off of the play board. When the vehicle is on the play board, however, the centering shaft 43 is pushed up above the edge of the V-notch 42 to allow the wheel 45 to turn left or right freely.

FIG. 3 depicts a third embodiment of a magnetically guided toy vehicle 50. This toy vehicle 50 has a body 51 in the form of a train, and includes a chassis 52 that holds a windup motor gear box 53 at the rear end. At the forward end of the chassis 52, there is located a front wheel housing 54, which is a substantially cylindrical sleeve in the chassis. The magnet and front wheel holder 55 has a cylinder 56 at the top that slides up into that housing sleeve 54 and is maintained by a fastener 57, such as a screw with a large head. At the bottom end of the magnet and wheel holder 55, there is an open yoke 58 through which the wheel 59 and wheel axle 60 are located. There is an arm 61 projecting forward of the magnet and wheel holder 55 that dips down to provide at the distal end a magnet

support 62 under which a magnet 63 is affixed. The magnet 63 is affixed at a position such that the bottom surface of the magnet is approximately the same height as the bottom surface of the front wheel so that both the magnet 63 and wheel 59 travel in close proximity of the play board 64 on which the toy vehicle is traveling. The toy vehicle 50, in this case a train, also includes a train body 51 which is affixed over on top of the chassis 52. As can be seen, the forward placed magnet 63 can ride along a printed metal line 65 in the center of parallel railroad tracks 66 on a play board 64.

As one skilled in the art may appreciate, with the variety of toy vehicles that may be made in accordance with the invention, there are also a correspondingly larger number of play boards with ferromagnetic guide paths that may be manufactured to go along with the toy vehicles as a play set.

For example, FIG. 4 depicts a play board 70 with a ferromagnetic guide path 71 underneath a graphic image of footprints 72 in a seemingly meandering maze pattern. The toy vehicle in this case is a robot figurine 73 that travels along the footprints by a spring windup motor driven drive wheel or even an electric motor. The robot has elongated feet 74 that provide the housing for the drive wheels and the front wheels/magnet assembly similar to the embodiments of toy vehicles described above.

FIG. 5 depicts a play board 75 for a train set. On the surface of the play board there is a printed train track 76 making a complete overlapping and curved circuit on the play board. In between the printed train tracks, there is a ferromagnetic line 77. This line is the guide path for the magnet 78 located on the forward projecting arm of the front wheel housing of a toy vehicle, such as a train shown in this figure. The play board 75 may include fanciful landscaping 79, houses 80 and even 3-dimensional buildings and other structures, such as a train station 81.

FIG. 6 depicts a perspective view of a play board 82 that includes a roadway 82 traveling through a variety of geographical landscapes. Under the roadway there is a ferromagnetic line 84 that provides the guide path for the toy vehicle 85. The play board 82 may be a printed paper or Mylar sheet with fanciful

landscaping and indicating a variety of terrain. Also, 3-dimensional structures may be added to the game board, such as bridge railings 86 as shown.

FIG. 7 depicts a perspective view of another embodiment of a play board 87 having a ferromagnetic line 88 on the play board that provides a guide path for the magnetically guided toy vehicle 89 to follow. In this embodiment, in addition to the graphic image of fanciful landscaping, three-dimensional objects are provided that may be formed by vacuum-forming a top plastic layer that is affixed to a play board substrate. The vacuum-formed layer may include projections such as a volcano 90, or mountain, a house 91, or a water tower 92, as shown.

FIG. 8 shows an exploded view of yet another embodiment of a play board 93. This play board 93 is in the form of a storybook. The storybook 93 includes rigid pages 94 on which a ferromagnetic guide path 95 is located. A magnetically guided toy vehicle 96 may then travel along those magnetic lines 95 as the story 96 printed on the story play board is read to a child by his parents or other caregivers.

Having described a few examples of play boards having ferromagnetic guided paths and tracks on them, it may be apparent that there are a variety of processes that may be used to manufacture such boards. The present invention provides an efficient cost effective and simple method for manufacturing play boards that take advantage of silk screening a ferromagnetic ink to form the ferromagnetic guide path or track for the toy vehicles. Silk screening has the advantage of allowing relatively high-speed mass production and depositing a sufficiently thick layer of ferromagnetic ink that is capable of attracting the guide magnet of a toy vehicle being propelled along the ink track. Although it is believed that roller printing or offset lithography techniques could be adapted to apply the ferromagnetic ink guide path, silk screening is the presently preferred printing technique for this application

FIG. 9 depicts exploded cutaway views of various play boards made according to different processes. FIG. 9A shows a three-layer play board 100. The bottom play board substrate layer 101 may be paper, cardboard, plastic, or other rigid material. The substrate may include multiple layers such as paper

laminated to a rigid support. Immediately on top of that substrate layer 101, a graphic image 102 is printed using regular ink materials. Preferably, an offset printing method is used. On the top layer, a ferromagnetic ink material 103 is silk screened as an overprint on top of the graphic in a path or track pattern for the toy vehicle to follow. This embodiment of a play board 100 has no protection layer or coating on top of the ferromagnetic ink to protect it. However, this enables the ferromagnetic ink to directly contact the magnet of the magnetically guided toy vehicle. Thus, it is believed that this embodiment would have the best performance in terms of vehicle operation. However, it is realized that over time, direct contact of the ferromagnetic ink with the magnet and other objects may cause some wear and tear and perhaps rub off or dislodge some of the ferromagnetic ink tracks.

Accordingly, as shown in FIG. 9B, an additional process step is provided to add a top surface protection layer over the ferromagnetic ink tracks. In this embodiment, a thin layer 109, such as polypropylene clear material, is laminated to the top of the play board 105 having the ferromagnetic ink tracks 108 that were silk screened over a graphic image 107 printed on a paper substrate 106. Alternatively, a clear-coat polymer varnish may be applied over the ferromagnetic ink guide path 108 for protection.

While the first two embodiments for the process for making the play board may have the best performance, in both embodiments the ferromagnetic ink layer is visible to an ordinary user of the play board. The natural color or dominant color of the ferromagnetic ink may be undesirable depending on the chosen fanciful decorations and landscaping for the play board. Accordingly, some alternative embodiments are provided to provide a play board with hidden ferromagnetic tracks.

As shown in FIG. 9C, a play board 110 is provided with such hidden ferromagnetic ink tracks. On one surface of a paper substrate 113 , a graphic image 114 of a landscape or other fanciful imagery set is offset printed. On the reverse side of the surface or paper, the ferromagnetic ink 112 is silk-screened in lines or tracks that are desired. Over the ferromagnetic ink tracks, a polypropylene

clear layer 111 is laminated to protect the ink from being scratched off. Because the graphic image 114 and the ferromagnetic ink tracks 112 are on opposite sides of a solid non-transparent substrate 113, the dark color of the ferromagnetic ink does not effect the graphic image 114 seen by a user playing with this play board. However, the user of the play board will see the tracks 112 when the board 110 is turned over, upside down, rather than its normal position for playing.

Accordingly, another embodiment of this invention provides for a play board that has a completely hidden magnetic ink track. As shown in FIG. 9D, a play board 115 is provided that has a paper substrate 119 with a graphic image 120 of a landscape or other fanciful decoration for playing on. The graphic image 120 is printed by offset printing on one side of the paper. On top of the graphic image 120, a UV varnish 121 or other clear overcoat may be provided to protect the graphic image from fading. On the reverse side of the paper substrate 119, the ferromagnetic ink tracks 118 or guide paths are screen printed. Over the screened ink tracks 118, a solid paper layer 116 is glued 117 to the substrate 119 thereby sandwiching the ferromagnetic ink tracks 118 between two solid, non-transparent layers of paper 116, 119. This embodiment is designed to prevent the ferromagnetic ink tracks 118 from being exposed from either surface of the game board. An additional advantage of this embodiment is that it adds to the mystery of the product with the ferromagnetic ink tracks not being visible. Accordingly, play boards can be manufactured in which a change in the travel direction of a toy vehicle on the play board is not apparent to a user. Another alternative, is that the ferromagnetic ink be silkscreened directly on the substrate and a graphic image printed over the ferromagnetic ink to provide some medium of protection to the ferromagnetic ink tracks, as well as hiding the tracks. It should be apparent, based on the foregoing description, that when the ferromagnetic ink is printed on the top side of the substrate, such as hard card stock, the thickness of the substrate does not affect the performance of the magnetically guided toys. On the other hand, when the ferromagnetic ink is printed on the reverse side of the substrate, it is preferred that the substrate be as thin as possible, such as paper, to keep the ferromagnetic ink as close as possible to the guiding magnet in the toy.

The above embodiments have been described as using a ferromagnetic ink. By the term "ferromagnetic ink", it is intended to refer to any ink containing components capable of attracting a magnet. Accordingly, this term is intended to include inks containing iron or any other material capable of exhibiting similar magnetic attracting characteristics.

The ferromagnetic ink material used in this invention is preferably a compound of electrolytic iron powder blended with different kinds of adhesives or ink vehicles. Depending on the type of adhesive or ink vehicle used, it can be classified as either water base or oil base ink. The water base ink preferably contains mainly boiled water and starch, whereas the oil base ink preferably is a mixture of lacquer rubber and synthetic rubber. The ideal ratio of iron powder to the adhesive is about 1:1 or 1.5:1 by weight. However, in embodiments where the ferromagnetic ink is not in direct contact with the magnet of the vehicle, for example, where the ferromagnetic ink tracks are screened on the reverse side of the paper substrate, then the iron powder content of the ink should be increased. This ratio is likely to vary depending on the particular application and the thicknesses of the substrates used, as well as the strength of the magnet used in the toy vehicles.

Because it is the iron powder that dominates the magnetic strength of the ink, the fineness and purity of the iron powder believed to be important. The iron powder used in a preferred embodiment of the ink has an average fineness of 30 microns per particle diameter, and less than 0.5% of its contents are foreign elements. A chemical analysis of the iron powder shows the following elements in percentage by weight:

Element	Total Fe	Carbon	Phosphorous	Sulfur	Silicon	Maganese	H_2 Loss
Percentage	≥ 99.5	< 0.005	< 0.002	< 0.01	< 0.005	< 0.0015	< 0.1

The exact amount of iron powder and ink depends on the process for making the play board. The more iron powder that is used, then the stronger the attraction to the toy vehicle will be. However, the increase in iron powder lowers

the screenability of the ink. For example, FIG. 11 depicts a play board that was printed with ink having iron powder up to 40%. Generally, if the quality of the components is high, then the ink has good printability and magnetic effect. An ink containing iron powder in the range of 50-60% also has demonstrated good printability and magnetic effect.

The ink may include other ingredients depending on the substrate that the ink is to be screened on. The ferromagnetic ink can be applied to numerous materials used as the substrate for the play board. These substrates include but are not limited to paper, card stock, plastic, fabric and leather. Conventional adhesives or ink vehicles typically used for screen printing inks on the substrates are believed to be applicable with the ferromagnetic ink in accordance with the present invention.

In addition to toy vehicles that travel along ferromagnetic ink tracks on a play board, one skilled in the art may envision other objects that travel on play boards having ferromagnetic ink tracks. For example, FIG. 10 depicts a moving toy dinosaur 126 on a play board 125. In this case, the play board 126 is printed with landscape and a variety of other miscellaneous objects on the terrain, such as tree stumps, bones and rocks. The ferromagnetic ink tracks are hidden in this play board. In one version, the object is a windup toy dinosaur that travels along the play board following the hidden tracks. In another version, the ferromagnetic ink is deposited as spots randomly distributed on the play board and the toy dinosaur 126 includes magnetically activated switches that turn on and off different functions.

For example, the switches can cause the legs 128 of the dinosaur to move back and forth to imitate a walking movement. In this case, the dinosaur is supported by a platform 127 underneath the belly of the dinosaur that supports the dinosaur and allows the legs to swing back and forth. When the dinosaur is pushed or driven across the play board and crosses the path of a randomly deposited ferromagnetic ink, a magnetic switch in the dinosaur is activated to cause the legs to move. Other functions that may be desirable in the toy dinosaur 126 include a mouth 129 that opens and closes in response to traveling across

certain ferromagnetic ink spots hidden below the play board. Another magnetically switched function may be a tail 130 of the dinosaur that swings back and forth.

Still yet another possibility includes placing magnetically actuated switches in the toy dinosaur that will be activated by magnetic objects other than in the play board. For example, as shown in FIG. 10A, a second toy dinosaur 131 may include hidden magnets under the skin and the upper body of that dinosaur. When the second dinosaur then approaches the first dinosaur as shown in FIG. 10A, and the magnets in the second dinosaur come in close proximity with the head of the first dinosaur, a magnetic switch in the first dinosaur's head would cause the first dinosaur's mouth to open and close and a microchip circuit to activate a voice in the form of a dinosaur scream.

Based on these few illustrations, a person skilled in the art should be able to apply these teachings to come up with other features and other types of toy objects or toy animals that can be animated through the use of ferromagnetic ink tracks and spots in play boards and in other objects. For example, FIG. 11 depicts a playboard with a graphic image of both land and water scapes. Ferromagnetic ink tracks travel in circuitous path both over the land and water. While toy boats and cars may follow these, animals and fish toys may also be made to follow the tracks.

The toy vehicle of this invention has the advantage that the special forward wheel and magnet assembly are advantageously positioned so that they can easily rotate around sharp corners and tight turns of a ferromagnetic ink track on a play board. Another feature of the forward wheel assembly is that it can oscillate up and down to follow the contours of a ferromagnetic ink surface, as well as the changes in the surface due to the built up thicknesses of various layers of ink or graphics applied. Another advantage of the toy vehicle in a preferred embodiment is that the front wheel returns to the center position automatically when the toy is lifted up off the surface of the play board.

Advantages of the embodiments for the method of making the play boards include that conventional screen printing techniques may be used to apply the

ferromagnetic ink tracks. Since these ink tracks may be applied to a thin paper substrate, printing a fanciful design or decorative graphic image on that substrate is also relatively simple following conventional offset printing techniques. Accordingly, the methods of these inventions allow for high speed mass production of game boards in large volume quantities. Another advantage of the process of this invention is that the play boards themselves may be on the paper wrapping that the toy vehicles are packaged, boxed or bagged in.

Although a variety of embodiments of the invention have been described above, those embodiments are intended only to illustrate and provide examples of the invention. The invention is to be defined, however, not by those illustrative embodiments, but rather by the appended claims that follow, and their equivalents.